

## **Component Failure Analysis from the U.S. Army ERDC-CERL Residential Proton Exchange Membrane Fuel Cells Demonstration**

S. Kenner<sup>1</sup>, N. Josefik<sup>2</sup>

<sup>1</sup>Concurrent Technologies Corporation, Johnstown, PA

<sup>2</sup>U.S Army Corps of Engineers ERDC-CERL, Champaign, IL

### **Background:**

The U.S. Army Engineer Research and Development Center, Construction Engineering Research Laboratory (ERDC-CERL) continues to manage The Department of Defense (DoD) Residential Proton Exchange Membrane (PEM) Fuel Cell Demonstration Project. This project was funded by the United States Congress for fiscal years 2001 through 2004. A fleet of 91 residential-scale PEM fuel cells, ranging in size from 1 to 5 kW, has been demonstrated at various U.S. DoD facilities around the world.

### **Introduction:**

This report expands on the basic performance of the fuel cell installations. It discusses the installations' tracked availability for the primary power applications and the reliability for the backup power locations. It additionally addresses fuel cell stack life for both primary and backup power systems and the lifespan and failure modes of selected fuel cell components, based on component type, age, and usage.

### **Approach:**

The performance of the fuel cells has been monitored over a 12-month field demonstration period. A detailed analysis has been performed cataloging the component failures. A discussion of the lifespan and failure modes of selected fuel cell components, based on component type, age, and usage will be provided. This analysis also addresses fuel cell stack life for both primary and back-up power systems. Several fuels were used throughout the demonstration, including natural gas, propane, and hydrogen.

The fuel cell contract awardees are responsible for all siting and installation requirements and for gathering and reporting performance data. The contract requirements are to provide a minimum of 12 months of fuel cell power with at least 90% unit availability. Each of the systems is also covered under a comprehensive maintenance contract for the duration of the demonstration period. This project has sought to maximize diversity of location, environment, application, and to provide a wealth of site-specific data. This supported the development of useful conclusions, despite a continuously-changing, multifaceted field. The data acquired and the conclusions developed are still bound by the similarity of the installed systems. The statistical samples are small in some of the cases, but this report continues to provide the data on the component failures.

This project is on-going, and many of the demonstrations are not yet complete. In addition, information gathering and reporting has matured throughout the 5 years of this project allowing improvements in the data analysis. This report documents and analyzes data based on demonstrations that have contributed sufficient maintenance records to the overall body of knowledge. The sites are distributed by year of service and fuel type. This analysis details the component replacement information provided by the contract awardees. Contract awardees reported replacement information in monthly updates specifically required by the ERDC/CERL statement of work.

### **Conclusion:**

This analysis will provide an overview of the ERDC-CERL PEM demonstration fuel cell applications and the corresponding data from the field demonstrations. Special emphasis will be placed on the components, fuel cell stack life, and input fuel characteristics of the systems demonstrated. The results of the analysis can be broken down into natural gas grid connected units, LPG grid connected units, and hydrogen backup power units. The differences between these units provide for limited comparisons between differing types of systems. The average life span of the individual fuel cell system components and the replacement cycle during this demonstration period will be documented. This analysis will expose the most commonly replaced components and their replacement history.